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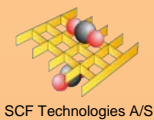
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# Structural analysis of Catliq<sup>®</sup> bio-oil produced by catalytic liquid conversion of biomass



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## Introduction

The potential offered by biomass for solving some of the world's energy problems is widely recognized. The energy contained in biomass can be utilized either directly as in combustion or by converting the biomass into a liquid fuel for transportation. The Catliq<sup>®</sup> (catalytic liquid conversion) process is a second generation process for the production of bio-oil from different biomass-based waste materials. The raw material used in this study was DDGS (Dried Distilled Grain with Solubles), a residual product in 1st generation ethanol production.

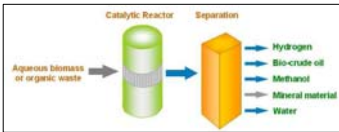


Figure 1. Catliq<sup>®</sup> process concept

## Aim

- Production of bio-oil from DDGS (Dried Distilled Grain with Solubles).

## Method

- Catalytic conversion of DDGS was performed in a pilot plant with a capacity of 10-20 L/h of wet biomass (see Fig. 2 & 3).
- The Process was carried out at subcritical conditions (280-350 °C and 180-250 bar).
- In the presence of homogeneous (KOH) and heterogeneous (ZrO<sub>2</sub>) catalysts.
- DDGS transformed to bio-oil (see Fig. 6), combustible gases and water soluble organic compounds.
- Bio-oil from DDGS was characterized by using equipment Avatar FT-IR 370 and GC/MS Varian CP-3800.

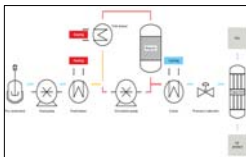


Figure 2. Catliq<sup>®</sup> process scheme



Figure 3. Catliq<sup>®</sup> pilot plant

Figure 4. DDGS (Dried Distilled Grain with Solubles)



Figure 5. Oil, water and salts after the reactor loop

Figure 6. Catliq<sup>®</sup> bio-oil



## Results

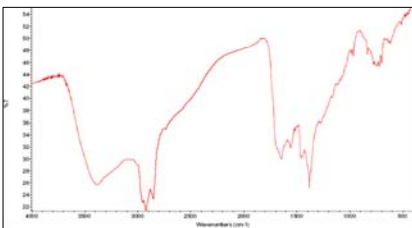


Figure 7. FT-IR spectra of the bio-oil

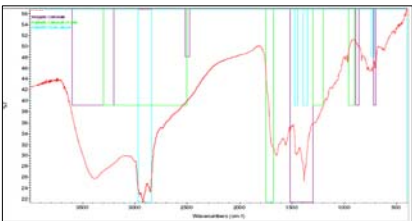


Figure 8. FT-IR spectra with group identification

| Type of functional group  | Wavenumber (cm <sup>-1</sup> ) |
|---|--------------------------------|
| Low frequency -OH group stretch, Phenols (aromatic ring) and Alcohols                               | 3600-3300                      |
| Inorganic Carbonates, bending vibration   | 3580-3300, 1510-1300           |
| O-H stretch of the Carboxyl group   | 3250-2500                      |
| Symmetrical and asymmetrical C-H stretching, Aliphatic -CH <sub>2</sub> and -CH <sub>3</sub> groups | 2960-2840                      |
| Inorganic Carbonates, absorption peaks  | 2515-2490, 890-860             |
| C=O stretch, Carbonyl   | 1725-1680                      |
| Ketone and Aldehyde stretching  | 1680-1620                      |
| C-H bending vibrations, alkane groups   | 1465-1380                      |

Table 1. Results of FT-IR for the bio-oil

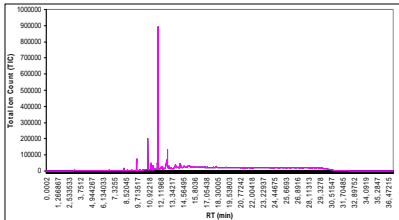


Figure 9. GC/MS spectrum for the bio-oil

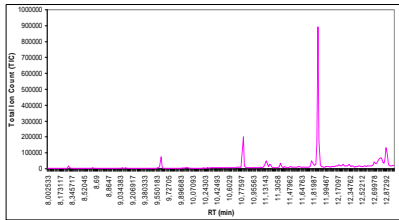


Figure 10. GC/MS spectrum for the specific compound peaks

| Compound  | RT (min.) |
|---|-----------|
| Hexadecanoic acid   | 11.885    |
| Tetradecanoic acid  | 10.809    |
| Octadecanoic acid   | 12.873    |
| 11-cis-Octadecenoic acid  | 12.793    |
| Dodecanoic acid   | 9.616     |
| Tridecanoic acid  | 11.147    |
| Palmitic acid   | 11.79     |
| n-Pentadecanoic acid  | 11.352    |
| β-D-Glucopyranoside, methyl 2,3-bis-O-(trimethylsilyl), cyclic methyl/bornate | 12.332    |
| Decanoic acid   | 8.299     |

Table 2. Identification of compounds in the bio-oil by GC/MS

## Conclusion

- The oil mainly consists of long-chain aliphatic acids.
- The content of oxygen was low, and the oxygen was mainly present in the form of acid groups
- The oil has a heat value of 36 MJ/kg.

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